

Citation:

Davis JN, Hodges VA, Gillham MB. Normal-weight adults consume more fiber and fruit than their age- and height-matched overweight/obese counterparts. *J Am Diet Assoc.* 2006 Jun;106(6):833-40.

PubMed ID: [16720124](#)

Study Design:

Case-Control Study

Class:

C - [Click here](#) for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

The purposes of our study were to assess differences in dietary intake between overweight/obese subjects and normal-weight controls matched for sex, age, and height and to use multiple regression techniques, controlling for confounding variables, to identify dietary components that best predict body fat deposition.

Inclusion Criteria:

- Cases were overweight and obese subjects
- Controls were normal weight subjects

Exclusion Criteria:

- Taking medications or diagnosed with any syndrome or disease that could influence dietary intake and body composition (eg, hypo/hyperthyroidism and diabetes).
- Currently or had been in the previous year involved with any diet, exercise, or weight-loss program.

Description of Study Protocol:**Recruitment**

- Subjects were recruited via flyers posted at local gyms, hospitals, sporting activities, and health centers and by sending out a campuswide e-mail to university faculty and staff.
- More than 90% of participants were recruited through the campuswide e-mail.

Design: Case-Control Study using a convenience sample

Blinding used (if applicable): Implied for analyses of dietary intake.

Intervention (if applicable): not applicable

Statistical Analysis

- Data were analyzed using the Statistical Package for the Social Sciences.
- Percent body fat, the only variable not normally distributed, was log transformed for analyses.
- Mean nutrient consumption and Food Guide Pyramid servings between groups, and for each sex between groups were compared with independent *t* tests.
- Hierarchical multiple regression analyses were employed to examine the extent to which different dietary factors predicted percent body fat with and without statistical control for potential confounding factors such as age, sex, physical activity-related energy expenditure as obtained from the YPAS, energy intake, and other macronutrients.
- Spearman correlation coefficients were used to assess relationships among energy and nutrient intake, Food Guide Pyramid servings, and percent body fat.
- Accepted statistical significance was $P < 0.05$.

Data Collection Summary:

Timing of Measurements

- Most data collection took place in a campus laboratory during a 2-hour appointment.

Dependent Variables

- Anthropometrics: body composition was measured by a licensed medical radiological technician using DXA (LUNAR, GE Medical Systems, Madison, WI).
- Physical activity: 40-item, investigator-administered Yale Physical Activity Survey (YPAS) to assess reported physical activity levels. Energy expenditure in the YPAS is based on the rates of oxygen consumption measured while people performed various specific activities.
- Dietary intake: semiquantitative 60-item Block food frequency questionnaire. A complete nutrient analysis, including macro- and micronutrients and Food Guide Pyramid servings per day were provided by Berkley Nutrition Services.

Independent Variables

- Overweight/obese: subjects were considered overweight or obese if they met two of three criteria:
 - overweight, BMI (calculated as kg/m^2) ≥ 25 and < 30 or obese, BMI ≥ 30 ;
 - current weight $\geq 125\%$ of standard body weight; and/or,
 - overweight/obese body fat percentage ranges as identified by Gallagher and colleagues (2000) using dual-energy x-ray absorptiometry (DXA).
- Normal weight: subjects qualified for the normal-weight group if they met two of three criteria:
 - BMI < 25 ;
 - current weight 90% to 110% of standard body weight; and/or,
 - body fat percentage ranges associated with health as classified by Gallagher and colleagues (2000).

Control Variables

Hierarchical multiple regression analyses were employed to examine the extent to which different dietary factors predicted percent body fat with and without statistical control for the following potential confounding factors:

- Age
- Sex
- Physical-activity related energy expenditure as obtained from the YPAS
- Energy intake and other macronutrients.

Description of Actual Data Sample:

Initial N: 138 subjects; 69 in each group

Attrition (final N):

- Thirty-two subjects were excluded because of an inability to find a matched control, and two subjects failed to provide adequate dietary data.
- Final sample included 104 adults: 52 overweight or obese (18 men, 34 women); 52 normal-weight subjects (18 men, 34 women) matched for sex, height (+/- 1 inch), and age (+/- 1 year).

Age: 19 - 69 years

Ethnicity: not listed

Other relevant demographics: not listed

Anthropometrics

- Cases and controls matched for sex, age and height
- BMI: 33.7 for Overweight/Obese group; 22.2 for Normal-Weight group
- Standard weight for height (%) : Overweight/Obese group 157; Normal-weight group 101.5
- Body fat (%): Overweight/Obese 43; Normal-Weight 25.1
- Activity (kcal/d expended): Overweight/Obese 1,381; Normal-Weight 1,301

Location:

Campus laboratory for measurements.

Summary of Results:

Key Findings:

- On average, the overweight/obese group was 31 kg heavier and had 71% more body fat than their matched controls.
- Subjects with overweight/obesity consumed significantly more total fat, saturated fat, and cholesterol ($P < 0.01$) and significantly less carbohydrate, complex carbohydrate, and dietary fiber per 1,000 kcal ($P < 0.01$) than their normal-weight matched controls.
- Neither total energy nor protein intake differed by group or by sex between groups.
- On average, overweight/obese subjects consumed about one more meat serving per day and one less fruit serving per day than their normal weight counterparts ($P < 0.01$).
- Surprisingly, consumption of added sugar did not differ between groups, nor did intakes of

bread, dairy products, or vegetables analyzed with or without potatoes.

- Reported intake of dietary fiber was inversely related to percent body fat without ($R^2 = 0.052$, $P = 0.02$) and with ($R^2 = 0.045$, $P = 0.013$) control for potential confounding factors.
- Servings of fruit per day were negatively related to percent body fat ($r = -0.40$, $P < 0.01$).

Other Findings:

- Diet composition between overweight/obese adults and their normal-weight counterpart differed substantially and may have played a vital role in promoting or preventing obesity.
- Although total energy intake did not differ significantly between the groups, the reported difference in the means for the two groups of about 200 kcal/day on the average in subjects matched for age and height would mediate toward weight gain of approximately 20 lb/year in the over-weight/obese group.
- Overweight/obese adults consumed a larger portion of their energy from fat and a smaller portion from carbohydrate, specifically dietary fiber and complex carbohydrate, than their matched controls.
- Normal-weight adults subjects received 33.5%, 17.2%, and 52% of energy from fat, protein, and carbohydrate, respectively; these values were similar to averages of US adults studied in the 1996 national consumption survey of 32.7%, 15.6%, and 51.2% energy from fat, protein, and carbohydrate, respectively.
- Corresponding values for overweight/obese subjects in our study were 38.7%, 18.1%, and 44.9% of total energy from fat, protein, and carbohydrate, respectively.
- When dietary fiber and complex carbohydrates were expressed per 1,000 kcal, normal-weight adults consumed an average of 33% more dietary fiber and 43% more complex carbohydrates daily than their overweight/obese counterparts. Dietary fiber and complex carbohydrate, expressed in grams and grams per 1,000 kcal, were inversely related to weight, BMI and most strongly to percent body fat ($r = -0.25$, $P < 0.01$).
- Dietary fiber was the only nutrient that when expressed by absolute weight accounted for a significant amount of the variance in percent body fat, both with and without controlling for the potential confounding variables.
- Unexpectedly, the frequency of consumption of added fats, oils, sweets, and sweetened carbonated beverages did not differ between groups in our study. Nor were differences evident between groups for percent of total energy from sweets or from added sugars in our sample.
- Overweight/obese subjects consumed approximately one less fruit serving daily when compared with normal-weight controls, which may partly explain differences in dietary fiber and carbohydrate between the two groups.
- Surprisingly, daily servings of vegetables were almost identical for both overweight/obese and normal weight groups, approximately 3.7 servings per day.
- Dairy and grain consumption was similar between groups, and for both, were below the recommended number of servings (1992 Food Guide Pyramid).

Author Conclusion:

Our results indicated that a diet containing more than average amounts of fiber, complex carbohydrate, and fruit was associated with normal body fat stores and standard weight for height. It appears that increasing dietary fiber, complex carbohydrate, and fruit in an individual's diet should be an important part of dietary interventions designed for weight management.

Reviewer Comments:

Well designed study. Greater sample size for men would be beneficial. Limitations as cited by authors:

- *Use of self-reported data to assess dietary intake.*
- *Use of a convenience sample made up entirely of volunteers who agreed to participate in a study evaluating dietary and exercise factors.*
- *No collection of socioeconomic data or parity data from women.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	Was the research question clearly stated?	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	Was the selection of study subjects/patients free from bias?	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	???

3.	Were study groups comparable?	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	???
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	Was method of handling withdrawals described?	Yes
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	Was blinding used to prevent introduction of bias?	???
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A

5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	N/A
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	Were outcomes clearly defined and the measurements valid and reliable?	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	N/A
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	Was the statistical analysis appropriate for the study design and type of outcome indicators?	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes

8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	Are conclusions supported by results with biases and limitations taken into consideration?	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	Is bias due to study's funding or sponsorship unlikely?	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes

Copyright American Dietetic Association (ADA).